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CONTENTS.

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TRANSACTIONS OF THE SOCIETY
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The Ephemeroptera of the Moor House National Nature Reserve, Westmorland

By D. T. Crisp* and J. M. Nelson

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This paper describes collections of Ephemeroptera nymphs taken on the Moor House National Nature Reserve during 1962 and 1963. Descriptions of the area have been published by Conway (1955) and Cragg (1961) and the climate has been described by Millar (in press). Some of the streams of the Reserve have been described by Crisp (1963) and Brown, Cragg and Crisp (in press). The latter account also gives references to published accounts of the fauna and flora of the Reserve.

The Ephemeroptera of the River Tees were included in a survey by Butcher, Longwell and Pentelow (1937), and additions to their list were made by Macan (1957), but these workers were chiefly concerned with the lowland parts of the river. The present survey covered only the upper reaches of the Tees, where it forms the boundary of the Moor House Reserve, together with eight of its tributaries which rise on the Reserve and three streams on the western side of the Pennine escarpment which are tributaries of the River Eden. The sampling stations covered the altitudinal range of 1150-2600 ft. O.D. (260-790 m.).

The species taken in the present survey are listed in Table 1. The list of Butcher *et al.* (1937), with additions by Macan (1957), is given for comparison.

Methods

Twelve watercourses were studied during the survey—the River Tees, eight of its tributaries and three tributaries of the River Eden (Crowdundle Beck, Knock Ore Gill and Swindale Beck). In each stream samples were taken along all or most of the length of the stream at places about 200 yd. (180 m.) apart. At each place samples were obtained by turning over stones and stirring gravel on the upstream side of a net of 10 in. (25·4 cm.) diameter with 60 meshes/in. (24 meshes/cm.). When slowly flowing places were sampled, sweeping motions were made with the net at the same time as the stream bottom was being stirred up. The net catches were hand sorted in the field.

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TABLE 1.

List of species taken, together with the range of altitudes over which the nymphs were found. The list for the Tees, published by Macan (1957) and based on the work of Butcher *et al.* (1937), is given for comparison.

Species	Altitudinal range (m. O.D.)	Number of specimens	Macan (1957)
Ameletus inopinatus Etn.	520-625	50	
Rhithrogena semicolorata (Curt.)	495-625	69	+
Heptagenia lateralis (Curt.)	350-670	85	+
Ecdyonurus venosus (Fabr.)	350-595	24	+
E. torrentis Kimmins	495-595	17	
Baetis rhodani (Pict.)	350-730	1400	+
B. pumilus (Burm)	350-660	18	+
B. tenax Etn./*B. vernus* Curt.	450-710	259	+
B. scambus Etn./*B. bioculatus* (L.)	480-640	10	+
Siphlonurus lacustris Etn.	480-625	333	+
Caenis rivulorum Etn.	400-550	12	
Ephemerella ignita Poda.	480-550	10	+

Macan (1957) also lists *Heptagenia sulphurea* (Müll.); *Centroptilum luteolum* (Müll.); *Ecdyonurus dispar* (Curt.); *Procloeon rufulum* Eaton; *Rhithrogena haarupi* Esb. Pet.; *Centroptilum pennulatum* Etn.; *Habrophlebia fusca* (Curt.); and *Paraleptophlebia submarginata* (Steph.).

The 138 sampling places were selected to cover as wide a range of habitat types as possible within each stream. The amount of time spent at each place was not standardised but was usually 5 to 10 min.

Several streams were sampled twice, once during the period April to June and again during July or August. Macan's (1957) findings suggest that a sampling regime of this type is probably adequate for obtaining a species list for the area but is not likely to give a very good measure of the proportions of the species because the species composition of the catch will depend partly on the times of year when the collecting was done.

Species Present and Their Altitudinal Distribution

The species found on the Reserve are listed in Table 1, together with the number of specimens of each species and an indication of the altitudinal range over which each species was found. The twelve species found on the Reserve include three not listed for the Tees by Butcher *et al.* (1937) or Macan (1957)—*Ameletus inopinatus, Ecdyonurus torrentis* and *Caenis rivulorum.* The absence of *Ameletus* from the list for the lower Tees might be expected because this species appears to be confined to high altitudes (Macan, 1957, Gledhill, 1959). Similarly, *E. torrentis* appears to be more typical of small stony streams than of rivers (Macan, 1957, 1961). *C. rivulorum,* however, may be found on stony substrata in streams and rivers (Macan, 1961) but may have

been missed by Butcher *et al.* because of its short imaginal life and restricted flying season.

The list of Butcher *et al.* (1937) includes *Baetis bioculatus* and *B. vernus*. There is no obvious morphological distinction between *B. vernus* and *B. tenax* nymphs but there appears to be a habitat difference, *B. vernus* occurring in lowland rivers and *B. tenax* in mountain streams (Macan, 1961, and pers. comm.). It has therefore been assumed that the specimens of *B. tenax/vernus* taken in the present survey are *B. tenax* and that they correspond to the *B. vernus* recorded by Butcher *et al.* Similarly it is not possible to separate the nymphs of *B. scambus* and *B. bioculatus*. As the nymphs of *B. bioculatus* are perhaps typical of rather more calcareous waters than those of *B. scambus* (Macan, 1961) it is probable that the specimens in the present collection are *B. scambus*.

Butcher *et al.* (1937) list ten species which were not recorded in the present survey. These ten species are typical of rivers and are found in rather slower flow conditions than those which occur on the Moor House Reserve.

Macan (1957) reviewed published information about the Ephemeroptera of small stony streams and, in the light of this and his own collections, he lists eight species which appear to be typical of such habitats. This list includes all the species found on the Reserve apart from *A. inopinatus, S. lacustris, C. rivulorum, B. tenax* and *B. scambus*. The absence of *Ameletus* and *B. tenax* from Macan's list is to be expected because his generalisation referred to stony streams at all altitudes and these two species appear to be almost or completely confined to mountain streams. Macan's list includes *Paraleptophlebia submarginata* and the absence of this species from the Moor House Reserve is difficult to understand because though it is a species generally found in slowly flowing water (Macan, 1957), so is *S. lacustris* which formed a major component of the present collections.

Kimmins (1942) gives indications of the altitudinal ranges of some of the British species of Ephemeroptera and the present survey extends the ranges of four species. Kimmins states that *Baetis rhodani* occurs up to at least 1000 ft. (300 m.) O.D., *B. pumilus* to at least 1500 ft. (460 m.) O.D., and *B. tenax* to at least 1700 ft. (520 m.) O.D. In the present survey they were found up to 2400 ft. (739 m.) O.D., 2175 ft. (660 m.) O.D., and 2325 ft. (710 m.) O.D. respectively. Similarly Kimmins states that *Ephemerella ignita* occurs up to at least 1500 ft. (460 m.) O.D. in the Lake District. At Moor House it was found up to 1800 ft. (550 m.) O.D.

Both Verrier (1953) and Gledhill (1960) have noted that the ratio of Baetidae to Ecdyonuridae and Ephemerellidae is higher in high altitude streams than in streams at lower altitudes. The preponderance of Baetidae in the collections from the Moor House area agrees with these observations.

Remarks on Individual Species

Table 2 shows the species composition of the catch from each of the streams studied. It also shows the National Grid References of the highest and lowest stations at which Ephemeroptera nymphs were taken in each stream.

TABLE 2.

Species analysis of the total catch from each stream during 1962. The National Grid References of the highest and lowest sampling points at which Ephemeroptera were taken in each stream are also given.

†Specimens too small to identify to species.

*Denotes streams sampled more than once during 1962.

‡Indicates that *Ameletus* was found present during additional sampling in the spring of 1963.

Stream and Sampling Points	*Ameletus inopinatus*	*Rhithrogena semicolorata*	*Heptagenia lateralis*	*Ecdyonurus venosus*	*E. torrentis*	*Baetis rhodani*	*B. pumilus*	*B. tenax*	*B. scambus*	*Siphlonurus lacustris*	*Caenis rivulorum*	*Ephemerella ignita*	*Ecdyonurus* sp.†	Totals
R. Tees NY/789307-730348*	‡	12	8	3	4	149		7	7	106	8	7	8	319
Trout Beck NY/760338-720313*	‡	5	20	3	1	222		35	3	37		1		327
Nether Hearth Sike NY/756332-749315*	19	20	9	1	4	200		6		5	1	1		266
Rough Sike NY/756325-756317	4									136				140
Moss Burn NY/753328-742309*	3	30	1	4	1	100	3	44						186
Little Dodgen Pot Sike NY/775323-769324*	9					19		37		11			2	78
Gt. Dodgen Pot Sike NY/769335-768330	15	1			1	3								20
Green Burn NY/779320-758313			1		1	104		11		14				131
Force Burn NY/783314-768297*		1	43		3	176		72		24		1		320
Swindale Beck NY/701286-721291	‡		2	3		212		33			2			252
Crowdundle Beck NY/684324-696334	‡			2	2	85	7	14			1			111
Knock Ore Gill NY/694300-716311			1	8		130	3						2	149
Totals	50	69	85	24	17	1400	18	259	10	333	12	10	12	2299

During 1962 *Ameletus inopinatus* was recorded in small numbers from most of the streams sampled before mid-June, but not from those sampled later. Additional searches during the spring

of 1963 showed that the nymphs of this species are widespread in the streams studied, provided they are looked for early in the season.

C. rivulorum and *E. ignita* were recorded only during the summer months and then only in small numbers. It may be that these two species were more abundant than the data suggest. The nymphs of *C. rivulorum* are small and slow moving and it is possible that small ones could have been overlooked during the earlier part of the season. *E. ignita* is known to occur as a nymph for only a very small part of the year (Macan, 1961) and is therefore probably under-represented in the samples obtained at Moor House.

The two *Ecdyonurus* species were found in similar numbers and were often found together at altitudes above 1600 ft. (490 m.) O.D. Below 1600 ft (490 m.) O.D. only nine specimens of *Ecdyonurus* were taken, and these were all *E. venosus*.

Nymphs of the genus *Baetis* formed the bulk of the catch and were found throughout the altitudinal range of the survey. They were found under a wide variety of flow conditions but appeared to prefer places where the flow was fairly rapid. Of the 1687 specimens taken, 1400 were *B. rhodani* and only 18 were *B. pumilus*, 259 *B. tenax* and 10 *B. scambus*. *B. rhodani* and *B. tenax* were found in most of the twelve streams but *B. scambus* only in Trout Beck and the River Tees, which were the two largest watercourses sampled and *B. pumilus* only in three small streams.

Siphlonurus lacustris was found in seven of the twelve streams studied. Kimmins (1942) states that this species can be found in lakes, slow streams and high tarns up to an altitude of 2500 ft. (760 m.) O.D. and Macan (1957) suggests that it is a cold water form which is characterized by sporadic occurrence. In a survey of ten small, stony Lake District becks Macan (1957) only found six specimens, but in the present survey it was the second most numerous species in the collections and was found in a wide variety of flow conditions.

Descriptions were made of all the sampling points and these have been used to group these points into three main categories. The first two categories refer to sampling points within the streams and reflect the flow conditions. Thus "pools" are regions where the stream flow is generally relatively slow and "riffles" are regions where the stream flow is fairly lively and the water often shallow and rather broken. Clearly the distinction is rather arbitrary because under flood conditions many of the places classified as "pools" will be subject to very rapid water flow, often more than 1 m./sec. (3 ft./sec.). The third category is referred to as "side pools" and consists of small puddles and pools situated along the stream margins and almost or entirely cut off from the main stream except during periods of flood. Table 3 shows the percentage composition of the total catch from each of these three types of place. Most of the species were taken in such small numbers that the table gives no real information about their distribution.

TABLE 3.

Percentage composition of the catch in each of three types of habitat.

Habitat	*Ameletus inopinatus*	*Rhithrogena semicolorata*	*Heptagenia lateralis*	*Ecdyonurus* spp.	*Baetis* spp.	*Siphlonurus lacustris*	*Caenis rivulorum*	*Ephemerella ignita*	Totals
Side Pools	—	—	—	—	5·9	91·2	2·9	—	100·0
Pools	4·7	0·4	3·3	1·4	54·9	35·3	—	—	100·0
Riffles	2·0	3·6	4·0	2·6	80·9	5·9	0·4	0·5	99·9
All Habitat Types	2·2	3·0	3·7	2·2	73·4	14·5	0·5	0·4	99·9

The results do, however, demonstrate the preference of *Baetis* nymphs for regions of fairly rapid flow and also show the importance of the "side pools" as habitats for *S. lacustris*. During the summer months these "side pools" often contain extremely dense populations of nymphs of *S. lacustris*. As this species appears not to be primarily a species of fast flowing waters, its nymph populations in the main stream courses may well suffer fairly severely from the effects of large summer floods. The populations of the "side pools" would then be important in enabling it to maintain itself in the area during those seasons which are unfavourable for the populations in the main stream courses. It is interesting to note, however, that though *S. lacustris* nymphs appear to be able to live in still water, no species of Ephemeroptera nymphs have been found in any of the peat pools on the Nature Reserve.

Summary

(1) A survey was made of Ephemeroptera nymphs in twelve watercourses on the Moor House National Nature Reserve, Westmorland. The results have been compared with Macan's findings in small Lake District streams.

(2) Twelve species were found and eight of these were species which would have been expected in high altitude stony streams. The remaining four species were *Siphlonurus lacustris, Caenis rivulorum,* and *Ecdyonurus venosus* and *B. scambus.*

(3) *S. lacustris* was the second most abundant species in the collections. The data show that it occurs in all types of flow conditions and is the most numerous species in small pools beside the main stream courses.

(4) *Ecdyonurus venosus* is considered by Macan (1957) to be more typical of stony rivers than of small streams. In the present survey it was found, along with *E. torrentis* in quite small streams.

(6) *Baetis scambus* was found only in the two largest watercourses studied.

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